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(54) Title: **METHOD FOR TREATMENT OF WET ORGANIC WASTE**

(57) Abstract

The invention relates to a method for treatment of biowaste, like household waste, for reduction of odour and microbial activity and use of treatment agent. A treatment agent is added at least once during a storage period prior to further treatment of the biowaste. An aqueous solution of formate, acetate or propionate, comprising their respective acids and their salts, is sprayed in amounts of 1-3 weight %, calculated as formate/acetate/propionate equivalents, on the biowaste having a moisture content of 50-75 weight %. Preferably a solution of 15-50 weight % potassium diformate is sprayed on the biowaste each time it is supplied to the bin in amounts of 50-70 ml/kg wet biowaste. The treated biowaste can further be processed to compost by addition of dry biowaste like bark, turf etc. in amounts of 25-75 weight % of the total mixture and said mixture can then be aerated.

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Method for treatment of wet organic waste

The present invention relates to treatment of biowaste, like household waste collected in containers, for reduction of odour and microbial activity, comprising adding a treatment agent at least once during a storage period before the treated biowaste is further processed or deposited. The invention also comprises use of a special type of treatment agent.

Biowaste comprises household waste collected in 150-200 litre bins for separate collection of wet organic waste fractions. Such waste can be placed in the bins several times a week and the bins are usually emptied after 7-14 days and transported to landfills or composting plants. Problems may occur during collection and storage of biowaste such as odour, flies and larvae, especially during the summer. Odour is also one of the main problems during composting. Accordingly, there is a need for treatment of biowaste to reduce and prevent odour and microbial activity. However, the biowaste should not be treated in such a way that problems arise during further processing or deposition of said waste. Special problems may arise if the treated biowaste shall be further processed to feedstuff. Then the treatment agent should preferably be completely degraded, and the products thereof must be acceptable in the feedstuff. Remaining treatment agent should also be acceptable.

Treatment of biowaste with nitrates like calcium nitrate, will under anaerobic condition reduce and/or prevent formation of hydrogen sulphide. Odour due to presence of hydrogen sulphide, organic acids, organic nitrogen and sulphur compounds can be substantially reduced by application of nitrates, but the

positive effects thereof are limited to anaerobic conditions. The effect of nitrate addition on various microbial activities resulting in odour formation, larvae etc. is also very limited.

Treatment of biowaste with organic acids like formic acid is known in the art. The effect on microbial activity has proved to be positive. The corrosion and etching problems related to such a treatment agent are, however, strongly limiting its use. In the case of further processing the biowaste it is essential that there has not been applied too much acid as remains will cause various unacceptable problems.

The main object of the invention was to arrive at a method of treating biowaste that would allow the waste to be stored for about 3 weeks without getting problems with odours, flies, larvae etc. and prevent/reduce microbial growth. Said treatment should not result in problems during further processing or depositing of the treated biowaste.

Another object was that the treated biowaste should be useful for further processing to compost or feedstuff.

A further object was that the treatment agent used should not cause any harm to the people being exposed to said agent during handling and processing of the biowaste.

The inventors started the development of a new method for treatment of biowaste by evaluating the various criteria to be met with regard to the treatment process itself and the resulting product, especially with regard to its further processing to foodstuff and compost.

Firstly, the treatment should result in substantial reduction in odour from the biowaste during storage for up to 3 weeks. Microbial activity and growth should be stopped or at least be kept at a very low level. Employed treatment agent should be biodegradable and remains thereof or its possible reaction products should not cause any problems in further processing of treated biowaste. In order to reduce/stop microbial activity, the pH of the biowaste/treatment agent mixture should preferably be below pH 4. Said mixture and the treatment agent should also be within acceptable ranges with regard to etching and corrosion to equipment and those exposed thereto during handling and processing.

When the treated biowaste is further processed to compost, the ideal pH would be in the range of pH 5-9 during the composting process, which initially also should have a minimum of microbial activity. If the treated biowaste shall be further processed to feedstuff, there are some general requirements to be met. Said biowaste shall not contain visible amounts of mould fungi, rod bacilli, larvae etc. indicating bacterial activity.

In view of the above, partly conflicting criteria and requirements, the inventors investigated various possible useful treatment agents. Application of formic acid was excluded primarily in view of its negative properties with regard to handling properties and corrosion. Salts of this acid and similar acids were then investigated, and it was then found that especially some of the disalts of such acids, possibly admixed with the corresponding acid, seemed to be applicable. Initially tests were performed to qualitatively determine the effects with regard to odour. These tests showed promising results provided sufficient amounts of treatment agent were evenly distributed throughout the biowaste. Even distribution could best be obtained if the biowaste had a minimum moisture content and the treatment agent was spread on the biowaste in the form of liquid/aqueous solutions. Application of treatment agent in the form of solids would however be possible.

Though formates comprising formic acid proved to give best effect, acetate or propionate comprising the corresponding acids were also found to be applicable.

The initial tests were followed up with similar treatment of the biowaste, but then recording and analysing the treated biowaste with regard to microbial activity, mould fungi and rod bacilli. Presence of larva in the biowaste during storage and at the end of the treatment periods for the biowaste were also recorded. During these experiments it was then found that the treatment with the various formate solutions could prevent and substantially reduce microbial activity for a prolonged time. Series of tests were then performed to verify the initial promising results. Further, the treated biowaste was further processed by composting and it was then found that this would be possible provided necessary amounts of bacteria were present for starting the composting process.

The further experiments showed that biowaste treated according to the invention with an aqueous solution of formate, acetate, or propionate, comprising their respective acids and disalts thereof, by spraying said solution in amounts of 1-3 weight%, calculated as formate/acetate/propionate equivalents, on the biowaste having a moisture content of 50-75 weight%, would have the odour and microbial activity substantially reduced.

Sodium-, ammonium or potassium diformate, especially the latter, proved to be especially effective in treating household waste. Preferred treatment would be a 15-50 weight% solution of potassium diformate sprayed on the biowaste each time it was supplied to the collecting bin in amounts of 50-70 ml/kg wet biowaste.

An aqueous solution of formic acid and formate in a ratio of 1:1 to 1:2 would also be a useful treatment agent.

Composting of biowaste treated according to the invention could be performed by mixing the biowaste with bark, turf or the like in amounts of 25-75 weight% of the total mixture which then was subjected to aeration. Before or during the initial composting process the biowaste/bark mixture could be inoculated with minor amounts of adapted micro-organisms, for instance by adding untreated biowaste or compost.

The scope and special features of the invention are as defined in the attached claims.

The invention is further explained in connection with the following examples.

Example 1

This example shows the effects of treatment of wet household waste with various treatment agents with regard to microbial growth. The effects on rod bacilli in household waste as function of treatment of different treatment agents are shown.

The experiments were carried out by filling household waste in 9 buckets, one used for control. On day one, 2.5 kg household waste was filled in each bucket and a treatment solution was sprayed on said waste. Later on 0.5 kg waste was filled in the buckets on each waste and treatment addition to the buckets. The experiment lasted for 22 days. The amount of mould fungi or rod bacilli were measured as colony forming units per gram (Cfu/g), as a function of time, type and amount of treatment agent. In the Tables 2-13, E means exponential. Samples for analysis were taken from the top (T) and bottom (B) layers of waste in the buckets. Each sample contained 50 grams household waste.

Table 1 shows type of treatment agent, amount applied, expressed as % formate equivalent, and sampling distribution. In the following tables the diformates are expressed as (50/50) or (70/30), which means that the treatment agent comprises an aqueous solution of 60 weight% diformate and 40 weight% water or a mixture of 1000 grams of this solution with 300 grams of 94% formic acid. The Controls, C-1 for the tests with potassium diformate and C-2 for the control in the comparative experiments, refer to addition of water only to the buckets each time household waste is filled therein. In the comparative experiments the effects of addition of formates are compared with addition of a mixture of Ca-, NH₄-, Na- and K-nitrates.

Table 1

Bucket	Agent	% Form.	Day T	5 BT	Day T	10 BT	Day T	17 BT	Day T	22 B
A	K-diformate (50/50) ¹	1.5	2	1	2	1	2	1	2	1
B	K-diformate (70/30)	1.5	2	1	2	1	2	1	2	1
C	K-diformate (50/50)	2.5	2	1	2	1	2	1	2	1
D	K-diformate (70/30)	2.5	2	1	2	1	2	1	2	1
E	NH ₃ -diformate (50/50)	2.5	2	1	2	1	2	1	2	1
F	NH ₃ -diformate (70/30)	2.5	2	1	2	1	2	1	2	1
G	Nitrate		2	1	2	1	2	1	2	1
H	Nitrate		2	1	2	1	2	1	2	1
C-1	Water		2	1	2	1	2	1	2	1
C-2	Water		2	1	2	1	2	1	2	1

The results from the aerobic gram negative rod bacilli in the samples from the top layer are shown in Table 2.

Table 2

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
A	K-diform(50/50) 1.5%	6.00E +06	2.50E +05	9.75E +06	3.18E +07	2.80E +04
B	K-diform(70/30) 1.5%	6.00E +06	1.75E +05	1.00E +00	2.75E +07	4.25E +03
C	K-diform(50/50) 2.5%	6.00E +06	1.00E +00	7.50E +05	1.00E +00	4.75E +03
D	K-diform(70/30) 2.5%	6.00E +06	1.00E +00	1.00E +00	5.00E +03	1.00E +00
C-1	Water	6.00E +06	1.25E +08	2.13E +09	1.75E +10	4.31E +10

The results from the bottom layer for comparative tests are shown in Table 3.

Table 3

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
E	NH ₃ diform(50/50) 2.5%	6.00E+06	2.00E+05	1.38E+06	5.00E+02	1.00E+00
F	NH ₃ diform(70/30) 2.5%	6.00E+06	7.50E+02	1.25E+06	1.00E+00	1.00E+00
G	Nitrate	6.00E+06	2.25E+07	2.50E+07	7.83E+08	9.50E+07
H	Nitrate	6.00E+06	1.01E+07	6.25E+07	7.75E+07	9.75E+07
C-2	Water	6.00E+06	7.50E+06	2.13E+09	1.75E+10	4.31E+10

The results from the bottom layer for agents being potassium diformate are shown in Table 4.

Table 4

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
A	K-diform(50/50) 1.5%	6.00E+06	5.00E+05	2.70E+04	3.50E+03	2.00E+03
B	K-diform(70/30) 1.5%	6.00E+06	1.00E+00	1.30E+06	6.00E+06	7.00E+06
C	K-diform(50/50) 2.5%	6.00E+06	1.00E+03	2.00E+03	2.50E+03	3.00E+03
D	K-Diform(70/30) 2.5%	6.00E+06	1.00E+00	1.00E+00	1.00E+00	1.00E+00
C-1	Water	6.00E+06	1.00E+07	4.75E+07	1.48E+06	3.25E+05

The results from the comparative experiments for the bottom layer are shown in Table 5.

Table 5

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
E	NH ₃ -diform(50/50) 2.5%	6.00E+06	1.00E+00	3.00E+03	2.40E+02	2.00E+03
F	NH ₃ -diform(70/30) 2.5%	6.00E+06	1.00E+00	1.00E+07	2.50E+03	5.00E+02
G	Nitrate	6.00E+06	1.00E+00	6.00E+07	1.00E+07	4.74E+04
H	Nitrate	6.00E+06	5.00E+06	4.50E+07	2.40E+06	9.00E+05
C-2	Water	6.00E+06	1.00E+07	4.75E+07	1.48E+06	3.25E+05

Experiments corresponding to those above for aerobic conditions were run under anaerobic conditions for negative rod bacilli. The results in the top layers for treatment with potassium diformate are shown in Table 6.

Table 6

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
A	K-diform(50/50) 1.5%	1.00E+00	1.00E+00	7.50E+03	1.76E+06	1.00E+00
B	K-diform(70/30) 1.5%	1.00E+00	1.00E+00	1.50E+05	3.35E+06	1.00E+00
C	K-diform(50/50) 2.5%	1.00E+00	1.00E+00	2.50E+04	1.00E+00	1.00E+00
D	K-diform(70/30) 2.5%	1.00E+00	1.00E+00	1.00E+00	7.50E+02	1.00E+00
C-1	Water	1.00E+00	3.75E+02	1.25E+08	7.50E+07	1.48E+08

The results for the comparative agents in the top layer are shown in Table 7.

Table 7

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
E	NH ₃ -diform(50/50) 2.5%	1.00E+00	1.00E+00	2.50E+04	1.00E+00	1.00E+00
F	NH ₃ -diform(70/30) 2.5%	1.00E+00	1.00E+00	4.25E+03	1.00E+00	1.00E+00
G	Nitrate	1.00E+00	2.50E+04	9.25E+05	7.00E+07	6.25E+04
H	Nitrate	1.00E+00	1.00E+00	2.50E+06	2.78E+06	1.60E+06
C-2	Water	1.00E+00	3.75E+02	1.25E+08	7.50E+07	1.48E+08

The results for the bottom layer with treatment with potassium diformate are shown in Table 8.

Table 8

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
A	K-diform(50/50) 1.5%	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
B	K-diform(70/30) 1.5%	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
C	K-diform(50/50) 2.5%	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
D	K-diform(70/30) 2.5%	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
C-1	Water	1.00E+00	1.50E+05	3.25E+07	1.33E+04	3.25E+05

The results from the comparative tests in the bottom layer are shown in Table 9.

Table 9

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
E	NH ₃ -diform(50/50) 2.5%	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
F	NH ₃ -diform(70/30) 2.5%	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
G	Nitrate	1.00E+00	1.00E+00	1.00E+06	1.00E+05	1.00E+00
H	Nitrate	1.00E+00	1.00E+00	1.00E+05	1.00E+03	1.00E+00
C-2	Water	1.00E+00	1.50E+05	3.25E+07	1.33E+04	3.25E+05

From the results given in Tables 2-9 it can be seen that the presence of rod bacilli in the buckets treated with potassium diformate under aerobic conditions is lower than for the control buckets and the results are best with the highest amounts of treatment agent (buckets C and D). In the buckets which are treated with ammonium diformate there is a marked reduction, but with those treated with nitrate (buckets G and H) there is no marked difference compared with the control bucket C-2. The tendency is the same for the bottom layer as for the top layer samples.

The experiments performed at anaerobic conditions show a substantial reduction of the rod bacilli when the household waste is treated with potassium diformate and best results are obtained with the highest amounts of treatment agent. Treatment with nitrate gives hardly any effect for the top layer samples, and the same goes for the bottom layer samples. The effects of the treatment agent ammonium diformate is lower than for potassium diformate.

Example 2

This example shows the results of tests performed as in Example 1 for recording the effects on mould fungi. The results of treatment with potassium diformate of the household waste on mould fungi growth are shown in Table 10.

Table 10

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
A	K-diform(50/50) 1.5%	3.40E+03	5.00E+05	1.38E+06	9.00E+04	3.00E+03
B	K-diform(70/30) 1.5%	3.40E+03	2.85E+05	2.41E+06	1.15E+06	1.00E+00
C	K-diform(50/50) 2.5%	3.40E+03	6.50E+04	6.00E+05	1.00E+00	2.50E+02
D	K-diform(70/30) 2.5%	3.40E+03	8.00E+03	1.00E+00	1.08E+04	2.50E+02
C-1	Water	3.40E+03	1.19E+07	3.80E+07	1.37E+07	9.44E+06

The results from the top layer for the comparative tests for mould fungi are shown in Table 11.

Table 11

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
E	NH ₃ -diform(50/50) 2.5%	3.40E+03	1.63E+05	4.50E+05	2.10E+04	1.00E+00
F	NH ₃ -diform(70/30) 2.5%	3.40E+03	2.52E+05	3.00E+05	1.00E+00	1.00E+00
G	Nitrate	3.40E+03	6.45E+06	3.14E+06	1.13E+07	2.78E+07
H	Nitrate	3.40E+03	2.25E+06	6.30E+06	1.32E+06	2.13E+07
C-2	Water	3.40E+03	1.19E+07	3.80E+07	1.37E+07	9.44E+06

The results on mould fungi growth from the bottom samples for household waste treated with potassium diformate are shown in Table 12.

Table 12

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
A	K-diform(50/50) 1.5%	3.40E+03	3.50E+04	1.00E+00	1.00E+00	1.00E+00
B	K-diform(70/30) 1.5%	3.40E+03	1.00E+00	6.60E+04	7.00E+04	1.00E+00
C	K-diform(50/50) 2.5%	3.40E+03	1.00E+04	4.50E+03	1.00E+00	1.00E+00
D	K-diform(70/30) 2.5%	3.40E+03	1.00E+00	1.00E+00	1.00E+00	1.00E+00
C-1	Water	3.40E+03	4.10E+06	2.40E+06	9.50E+05	8.50E+03

The results from the bottom layer for the corresponding comparative experiments are shown in Table 13.

Table 13

Bucket	Agent	Day 1	Day 5	Day 10	Day 17	Day 22
E	NH ₃ -diform(50/50) 2.5%	3.40E+03	1.00E+00	1.00E+00	1.00E+00	1.00E+00
F	NH ₃ -diform(70/30) 2.5%	3.40E+03	1.00E+00	1.00E+00	1.00E+00	2.50E+03
G	Nitrate	3.40E+03	1.02E+07	4.00E+06	1.51E+05	1.50E+05
H	Nitrate	3.40E+03	7.55E+06	5.50E+06	1.00E+05	7.50E+04
C-2	Water	3.40E+03	4.10E+06	2.40E+06	9.50E+05	8.50E+03

The results from the mould fungi experiments shown in Tables 10-13 clearly demonstrate that treatment of household waste with diformates, especially potassium diformate, substantially reduces the development of mould fungi. It is also evident that it is necessary to apply a minimum amount of treatment agent as shown by differences in effect when 1.5% and 2.5% treatment agent are used. The effect of ammonium diformate is somewhat lower than for potassium diformate. From the comparative tests it can be seen that treatment with nitrate hardly gives any effect compared with the control (C-2). The results are about the same for the top and bottom layers with regard to treatment with nitrate.

Example 3

This example shows the effect of the treatment with a 2.5 weight% solution of potassium diformate under aerobic- and anaerobic condition on microbial degradation processes in wet household waste. The effect under aerobic conditions is shown as gram CO₂ formation/kg dry matter as function of time. The control curve of Figure 1 refers to addition of water only to the waste. The effect under anaerobic conditions is given as CO₂ production in volume% as function of time. This is shown in Figure 2, which clearly shows that the CO₂ production was stopped almost completely by the potassium diformate treatment, which means that the microbial activity was stopped correspondingly.

Example 4

This example shows composting of household waste treated with and without a solution of potassium diformate in water. The dosage was 55 ml/kg wet waste. The initial water content for composting was adjusted to about 55%. The control experiments were performed by adding water instead of the diformate solution or inoculum. By inoculum is here meant compost which previously has been exposed to formate. The composting experiments were carried out in three 100 litre bioreactors, and a continuous aeration was achieved by means of compressed air. Bark was mixed with waste in a 1:1 weight ratio. The reactors were continuously aerated with 50 up to 100 l/h corresponding to an aeration of 1.7-1.75 l/kg dry matter per hour.

Reactor I contained biowaste having been treated with 1.5% potassium diformate and mixed with 1 weight% inoculate. Reactor II contained biowaste treated with the same amount of diformate and this was mixed with 20 weight% inoculate. Reactor III is the control reactor. The results of these experiments are shown in Figure 3.

The diformate was completely degraded and provided that not too much diformate had been used during the treatment of the waste prior to the composting process, it performed well. Accordingly, biowaste treated with diformate during its storage in collecting bins for up to three weeks, can be further processed by composting. In case of low microbial activity at the start of the composting process, this can easily be speeded up by addition of minor amounts inoculant as shown in Figure 3.

From the above examples it can be seen that the new way of treating biowaste results in substantial reduction of odour and microbial activity during collection and storage of the biowaste. The treatment agent is biodegradable, and the thus treated biowaste is useful for further processing.

Claims

1. Method for treatment of biowaste, like household waste collected in containers or bins, for reduction of odour and microbial activity, comprising addition of a treatment agent at least once during a storage period prior to further treatment of the biowaste,
characterized in that
an aqueous solution of formate, acetate or propionate, comprising their respective acids and their disalts, is sprayed in amounts of 1-3 weight%, calculated as formate/acetate/propionate equivalents, on the biowaste having a moisture content of 50-75 weight%.
2. Method according to claim 1,
characterized in that
an aqueous solution of sodium-, potassium- or ammonium diformate is applied.
3. Method according to claim 1,
characterized in that
a solution of 15-50 weight% potassium diformate is sprayed on the biowaste each time it is supplied to the bin in amounts of 50-70 ml/kg wet biowaste.
4. Method according to claim 1,
characterized in that
the aqueous solution applied comprises formic acid and formate, in a ratio of 1:1 to 1:2.

5. Method according to claim 1,
characterized in that
the treated biowaste is further processed to compost by addition of dry
biowaste like bark, turf etc. in amounts of 25-75 weight% of the total
mixture and that said mixture is aerated.
6. Method according to claim 5,
characterized in that
before or during the initial composting process inoculation of the mixture
with adapted micro-organisms is performed.
7. Method according to claim 5,
characterized in that
the inoculation is performed by adding minor amounts of untreated
biowaste or compost.
8. Use of sodium, ammonium or potassium mono- or disalts of formic-,
acetic- or propionic acid, comprising their respective acids, for treatment
of biowaste.
9. Use according to claim 8, of potassium diformate, comprising formic
acid, for treatment of biowaste.

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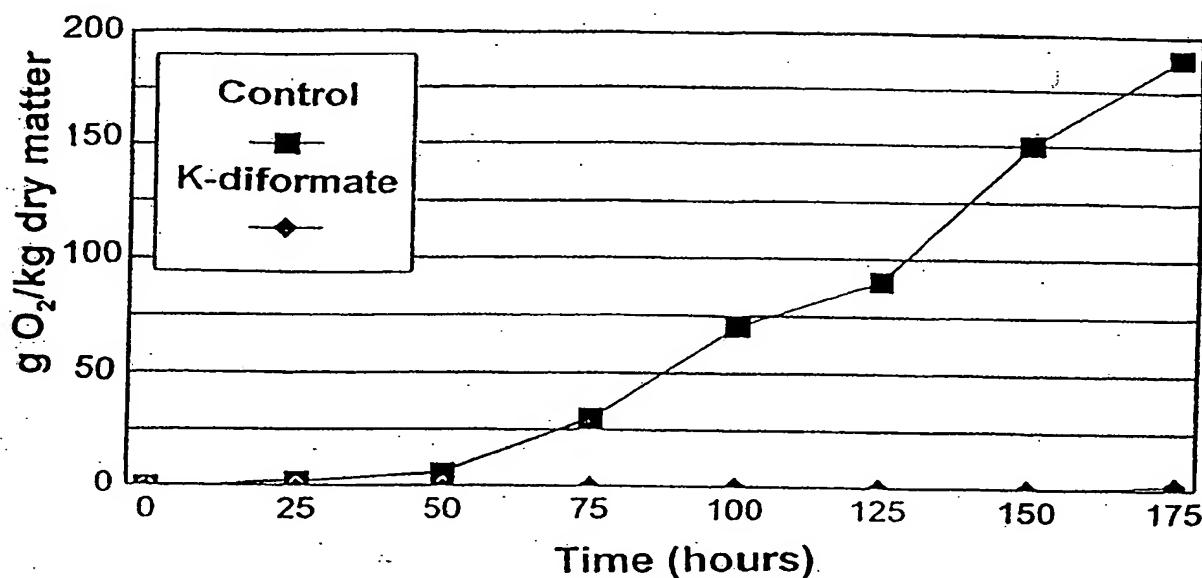


Fig. 1

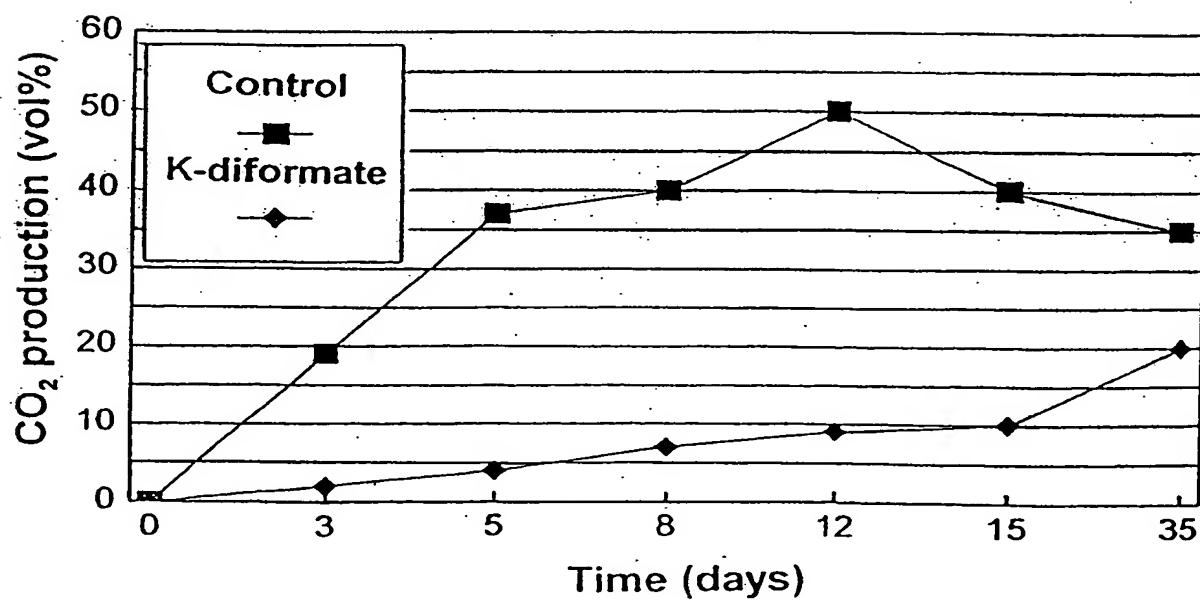


Fig. 2

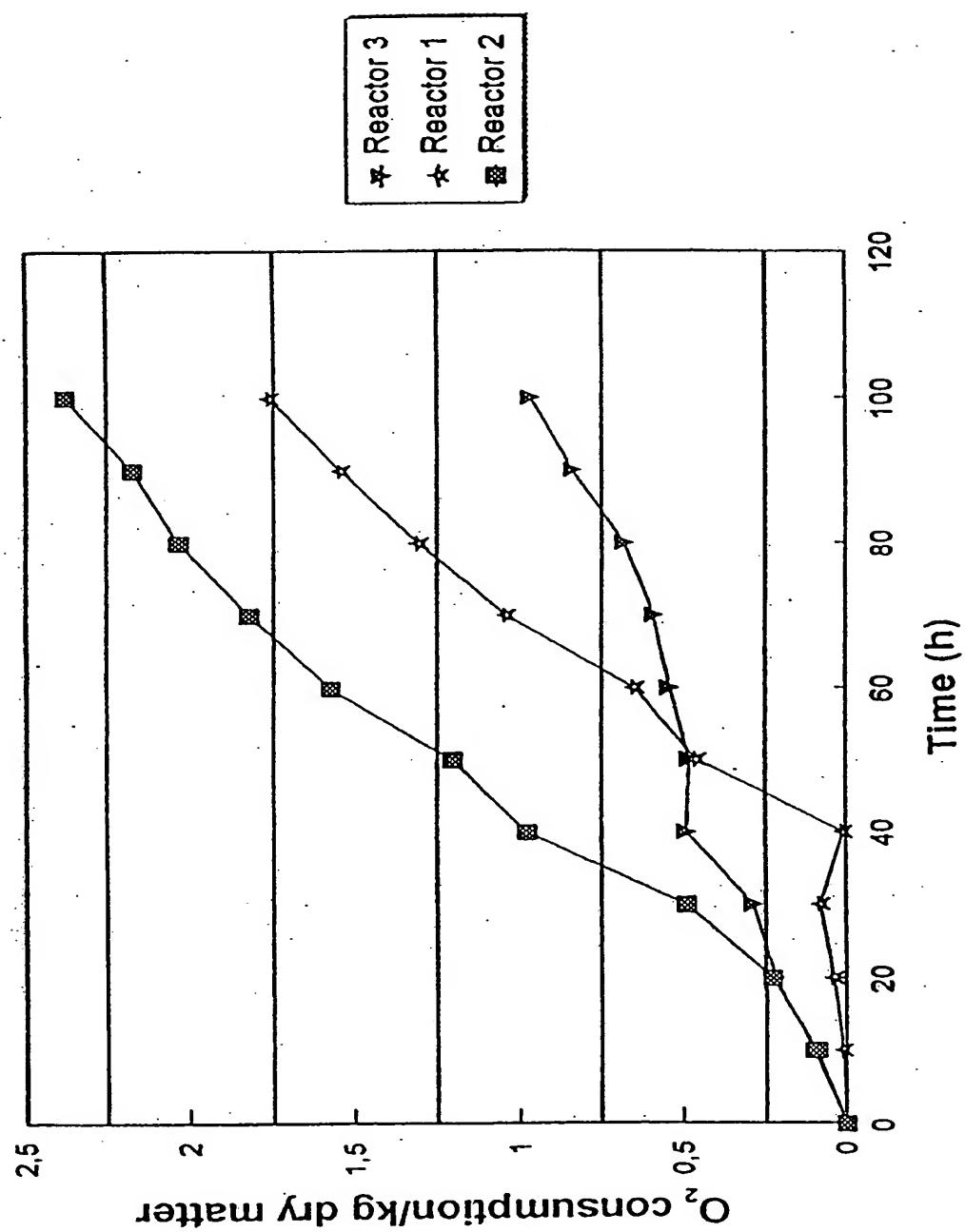


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 97/00289

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A61L 2/16, A61L 9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A61L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 3329338 A1 (VITAL DISPOSABLES B.V.), 1 March 1984 (01.03.84), claims 1-4 --	1,8
X	DE 3810281 A1 (KLEINDIENST GMBH), 5 October 1989 (05.10.89), column 2, line 20, claim 6 --	1,8
A	DE 3903825 A1 (LOCHNER, GUDRUN), 24 August 1989 (24.08.89), claims 1-188 --	1-9
A	WO 9516470 A1 (HADDON, BRUCE, ALEXANDER), 22 June 1995 (22.06.95), claims 1-29 -----	1-9

 Further documents are listed in the continuation of Box C. See patent family annex.

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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

27 March 1998

Date of mailing of the international search report

01 -04- 1998

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. + 46 8 666 02 86

Authorized officer
Agneta Änggård
Telephone No. + 46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/NO 97/00289

02/03/98

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 3329338 A1	01/03/84	BE 897509 A DK 386883 A NL 8203298 A	10/02/84 25/02/84 16/03/84
DE 3810281 A1	05/10/89	NONE	
DE 3903825 A1	24/08/89	NONE	
WO 9516470 A1	22/06/95	AU 1268595 A AU PM294993 D GB 2300566 A GB 9612605 D	03/07/95 00/00/00 13/11/96 00/00/00

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